

Conrad Mook

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(Technical Progress Report)

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THERMAL CONTROL SURFACES

National Aeronautics and Space Administration
George C. Marshall Space Flight Center
Huntsville, Alabama

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THERMAL-CONTROL SURFACES

Report Period 2/1/68 through 2/29/68

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Contract NAS8-21074
IITRI PROJECT U6061

I. INTRODUCTION

The Pegasus III spacecraft, which was launched from Cape Kennedy on July 30, 1965, was used for a unique experiment in terms of environmental effects on thermal-control surfaces. A large number of retrievable coupons were coated with various thermal-control materials and were placed on the Pegasus III satellite with the intent that they would eventually be (1) measured "optically" in situ, and/or (2) returned to earth for evaluation by a rendezvousing astronaut.

This research program was planned to provide the technical background that is necessary for the proper evaluation of the space-environment-induced damage sustained by the Pegasus coupons.

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II. WORK PERFORMED

A. IRIF Space-Simulation Test 16

IRIF screening test 16 was completed after a total exposure of 3600 ESH of ultraviolet irradiation in vacuum. In situ reflectance measurements were taken after exposures of 0, 100, 450, 1050, 2000, 2900, and 3600 ESH and after 18 hrs at atmospheric pressure. Because of a leak that developed in a bellows during the terminal in situ measurements at 3600 ESH, only two specimens were measured in vacuum; all specimens were measured in air, however. The data are presented in Table 1.

Although glow discharge was observed during the start-up of this test, it was considerably less than that observed at the beginning of test 15 (see Report IITRI-U6061-11). On the basis of the damage sustained by the Pegasus S-13 specimen, Test 16 is believed to be comparable to Test 13. The severity of the damage sustained by the zirconia-pigmented potassium silicate specimen (#6) cannot be explained (the $\Delta\alpha$ in test 13 was only 0.125 after 2800 ESH compared to 0.269 after 2900 ESH in the present test). These data are being plotted and will be presented graphically in the next progress report.

The excellent stability exhibited by the zinc sulfide paint, specimen #2, was not unexpected. Studies by the author a number of years ago indicated the general stability of ZnS. Unfortunately zinc sulfide paints exhibit high solar absorptance and have no value over S-13G at this time. In addition, a cursory plot of the α of Specimen #2 against the logarithm of time shows a serious escalation of damage beginning at about 3000 ESH.

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Table 1

EFFECT OF UV IRRADIATION IN THE IRIF ON SELECTED THERMAL-
CONTROL SURFACE COATINGS (IRIF Test 16; Solar Intensity 6X)

Sample No	Surface Coating	Exposure, ESH	Solar Absorptance			
			α_1	α_2	α_s	$\Delta \alpha_s$
1	LMSC r-TiO ₂	0	.124	.062	.186	-
		100	.158	.097	.255	.069
		450	.168	.106	.274	.088
		1050	.183	.119	.302	.116
		2000	.206	.126	.332	.146
		2900	.210	.140	.350	.164
		3600	.216	.140	.356	.170
		Air	.181	.086	.267	.081
2	ZnS (O-I 650 Resin)	0	.112	.153	.265	-
		100	.118	.152	.270	.005
		450	.126	.151	.277	.012
		1050	.140	.146	.286	.021
		2000	.160	.146	.306	.041
		2900	.163	.147	.310	.045
		3600	.191	.169	.360	.095
		Air	.181	.156	.337	.072
3	α -Al ₂ O ₃ (PS-7)	0	.055	.058	.113	-
		100	.094	.057	.151	.038
		450	.153	.061	.214	.101
		1050	.200	.074	.274	.161
		2000	.233	.081	.314	.201
		2900	.244	.092	.336	.223
		Air*	.250	.110	.360	.247
4	White Kemacryl	0	.165	.148	.313	-
		100	.214	.186	.400	.087
		450	.268	.184	.452	.139
		1050	.314	.190	.504	.191
		2000	.359	.197	.556	.243
		2900	.369	.217	.586	.273
		Air*	.373	.192	.565	.252
5	S-13 (Pegasus)	0	.116	.083	.199	-
		100	.127	.128	.255	.056
		450	.156	.161	.317	.118
		1050	.179	.180	.359	.160
		2000	.208	.180	.388	.189
		2900	.224	.203	.427	.228
		Air*	.223	.112	.335	.136
6	ZrO ₂ (PS-7)	0	.094	.080	.174	-
		100	.148	.089	.237	.063
		450	.236	.104	.340	.166
		1050	.260	.097	.357	.183
		2000	.272	.120	.392	.218
		2900	.288	.155	.443	.269
		Air	.280	.134	.414	.240
7	Cat-a-lac Black	0	.478	.487	.965	-
		100	.476	.487	.963	-.002
		450	.472	.486	.958	-.007
		1050	.470	.477	.947	-.018
		2000	.470	.478	.948	-.017
		2900	.468	.467	.935	-.030
		Air	.468	.486	.954	-.011
8	SnO ₂ (PS-7)	0	.092	.061	.153	-
		100	.111	.064	.175	.022
		450	.143	.065	.208	.055
		1050	.190	.077	.267	.114
		2000	.209	.079	.288	.135
		2900	.232	.083	.315	.162
		Air*	.209	.085	.294	.141
9	S-13G (Batch A-466)	0	.119	.097	.216	-
		100	.126	.104	.230	.014
		450	.143	.101	.244	.028
		1050	.148	.109	.257	.041
		2000	.174	.103	.277	.061
		2900	.189	.109	.298	.082
		Air*	.190	.109	.299	.083

* Air measurement taken after 3600 ESH

B. Glow-Discharge Confinement

An ion-sputter pump creates a glow discharge during start-up. This glow discharge is composed of electrons and positively charged ions. The ions result mostly from desorbed molecules which are sorbed by the metal on the pump surface. If the pump is "dirty", the start-up time can be prolonged while the pump outgasses - usually and predominately water - prolonging glow discharge.

We have installed two grids in IRIF II just above the throat of the 400 l/s Ultec sputter-ion pump. These grids are screenes with 80 per cent open area; they are electrically isolated from the pump and from one another. They are designed so that a voltage in excess of 2000v can be impressed on each grid.

Our initial experiments have indicated that by maintaining the top grid at approximately -20v and the bottom grid (closer to the pump) at +30v, the current to each grid can be minimized (see Fig. 1). The voltage impressed on the grids must be varied slightly as the pump voltage changes. We are continuing this investigation in order to more precisely fix the grid voltage limit.

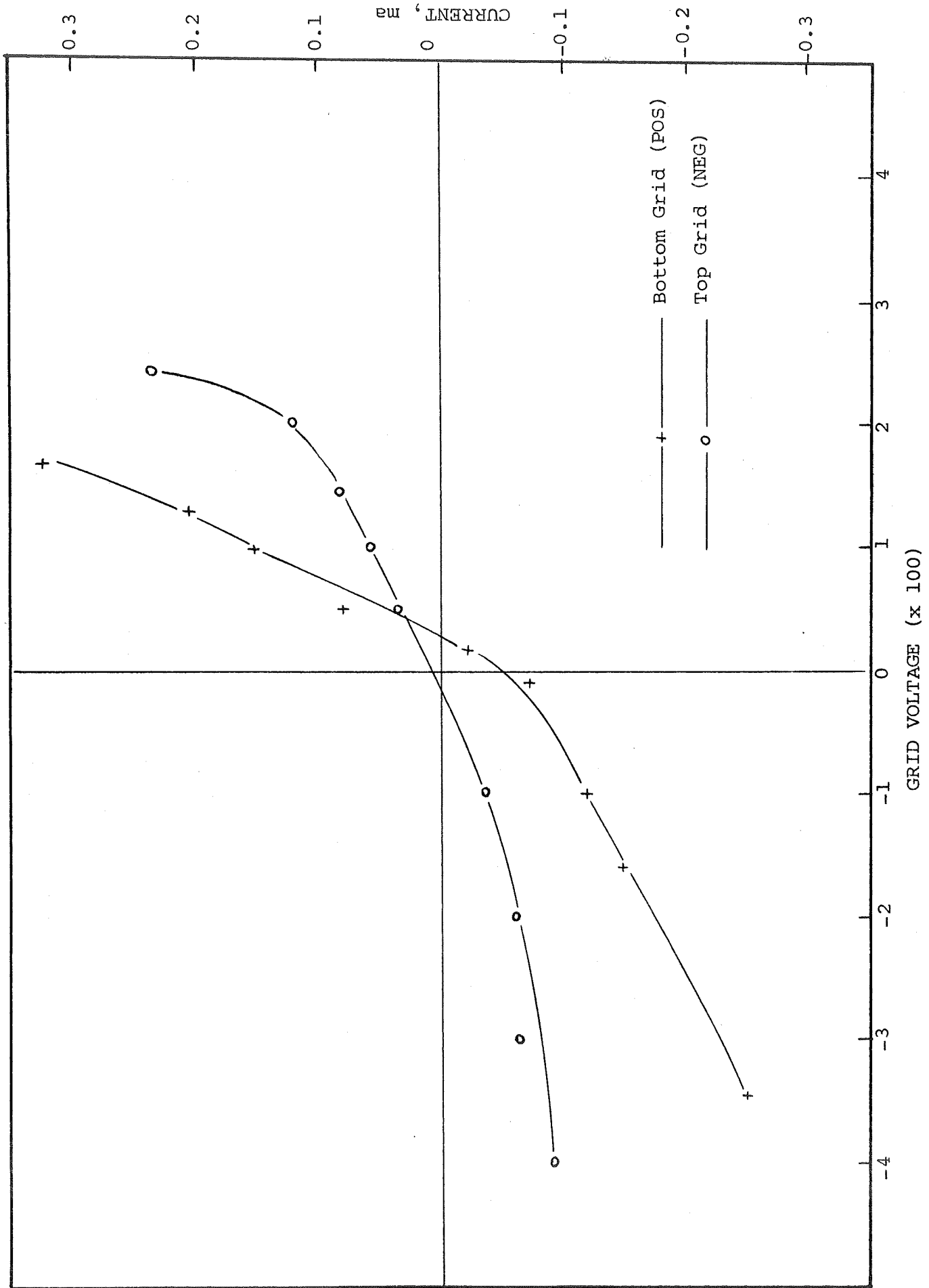


Figure 1: GRID CURRENT AS A FUNCTION OF GRID VOLTAGE


III. FUTURE WORK

We believe that the problem of glow discharge-induced damage should be more fully elucidated prior to initiation of gaseous adsorbate studies. Additional investigations of glow discharge confinement are currently under way.

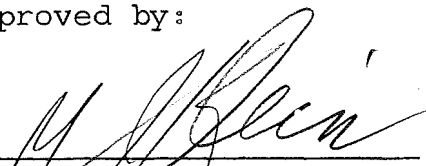
IRIF II has been used successfully for two space simulation tests employing a high-pressure, 5 Kw mercury-xenon source. Some differences have been noted but are not yet fully explained. Damage at visible and near-ultraviolet wavelengths appears slightly more severe than for equal doses employing high pressure mercury-argon (A-H6) lamps.

Respectfully submitted,

IIT RESEARCH INSTITUTE


G. A. Zerlaut
Senior Chemist - Group Leader.

Approved by:


M. J. Klein
Director
Chemistry Division

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